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NOTICE OF CHANGE

MIL-STD-1687A(SH)
NOTICE 1
23 SEPTEMBER 1994

MILITARY STANDARD
THERMAL SPRAY PROCESSES FOR NAVAL SHIP MACHINERY APPLICATION

TO ALL HOLDERS OF MIL-STD-1687A(SH):

1. THE FOLLOWING PAGES OF MIL-STD-1687A(SH) HAVE BEENREVISED AND SUPERSEDE THE PAGES LISTED:

NEW PAGE	DATE	SUPERSEDED PAGE	DATE
1	11 February 1987	1	23 September 1994
2	11 February 1987	2	REPRINTED WITHOUT CHNAGE
17	11 February 1987	17	REPRINTED WITHOUT CHANGE
18	11 February 1987	18	23 September 1994
21	11 February 1987	21	23 September 1994
22	11 February 1987	22	REPRINTED WITHOUT CHANGE

2. RETAIN THIS NOTICE AND INSERT BEFORE TABLE OF CONTENTS.

3. Holders of MIL-STD-1687A(SH) will verify that page changes and additions indicated above have been entered. This notice page will be retained as a check sheet. This issuance, together with appended pages, is a separate publication. Each notice is to be retained by stocking points until military standard is completely revised or canceled.

Preparing activity:
Navy - SH
(Project MFFP-N550)

AMSC N/A AREA MFFP

DISTRIBUTION STATEMENT A. Approved for public release; distribution unlimited.

1. SCOPE

1.1 Scope. This standard covers thermal spray processes for machinery repair and corrosion protection of Naval ship machinery, except the spraying of aluminum for corrosion protection which is covered in DOD-STD-2138. This standard does not apply to primary and secondary systems of nuclear ships. Included are requirements for the qualification of thermal spray procedures and operators, requirements and guidance for use of thermal spray material and equipment, quality assurance requirements, and descriptions of applicable qualification tests.

1.1.1 The thermal spray processes covered by this standard are: (a) wire spraying of consumable coating material using oxygen-fuel gas, or using two consumable electrodes in an electric arc system, and (b) powder spraying, using oxygen-fuel gas or plasma arc.

1.2 Application. Thermal spray coatings shall be used only for machinery applications specifically permitted herein (see 5.5.2) or for which prior approval has been obtained from the Naval Sea Systems Command (NAVSEA).

1.2.1 Requirements of this standard pertain only to the thermal spray coatings applied to ferrous and non-ferrous metal substrates.

2. REFERENCED DOCUMENTS

2.1 Government documents.

2.1.1 Specifications and standard. Unless otherwise specified, the following specifications and standard of the issue listed in that issue of the Department of Defense Index of Specifications and Standards (DoDISS) specified in the solicitation form a part of this standard to the extent specified herein.

SPECIFICATIONS

FEDERAL

BB-A-106 - Acetylene, Technical, Dissolved.
BB-A-1034 - Air, Compressed, for Breathing Purposes.
BB-H-886 - Hydrogen.
BB-H-1168 - Helium, Technical.
BB-O-925 - Oxygen, Technical, Gas and Liquid.

MILITARY

MIL-M-3800 - Metallizing Outfits (Wire-Gas), Guns and Accessories.
MIL-W-6712 - Wire; Metallizing.
MIL-A-18455 - Argon, Technical.

Supersedes page 1

MILITARY (Continued)

MIL-P-80109 - Plasma Spray Systems, Powder, Guns, and Accessories.
MIL-M-80141 - Metallizing Outfits, Powder-Gas, Guns and Accessories.
MIL-M-80226 - Metallizing System, Wire, Electric Arc, Guns and Accessories.
MIL-P-83348 - Powders, Plasma Spray.

STANDARD

MILITARY

DOD-STD-2138 - Metal Sprayed Coating Systems for Corrosion Protection Aboard Naval Ships. (Metric)

(Copies of specifications and standards required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting officer.)

2.1.2 Other Government publication. The following other Government publication forms a part of this specification to the extent specified herein. Unless otherwise specified, the issues shall be those in effect on the date of the solicitation.

PUBLICATIONS

DEPARTMENT OF TRANSPORTATION (DOT)

Code of Federal Regulations (CFR) 29, 1910.107 - Spray booths.

(The Code of Federal Regulations (CFR) and the Federal Register (FR) are for sale on a subscription basis by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.)

2.2 Other publications. The following documents form a part of this standard to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted shall be those listed in the issue of the DoDISS specified in the solicitation. The issues of documents which have not been adopted shall be those in effect on the date of the cited DoDISS.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

C 633 - Standard Test Method for Adhesion or Cohesive Strength of Flame-Sprayed Coatings. (DoD adopted)
D 4285 - Standard Test Method for Indicating Oil or Water in Compressed Air.

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.)

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5.3 Materials.

5.3.1 Coating materials.

5.3.1.1 Coating type. The coating material shall be as specified in the contract or by engineering personnel of the performing activity.

5.3.1.2 Thermal spray wire and powder. Wire and powder used for thermal spraying shall be in accordance with MIL-W-6712 or MIL-P-83348, respectively. Materials not included in MIL-W-6712 or MIL-P-83348 may be used, providing a qualified spray procedure has been established for the material (see 4.3). Wire and powder shall be the same as specified in the procedure to be used.

5.3.1.3 Storage, identification, and separation of wire and powder. Stored wire and powder shall be protected from environments that can harm the quality of sprayed coatings. Powder suspected of being contaminated by foreign matter shall not be used. Storage recommendations of the coating manufacturer shall be followed. Powders shall be shaken prior to use to break up any segregation or agglomeration that may have occurred during storage. The contents of powder containers and wire reels shall be identified.

5.3.2 Thermal spray gases.

5.3.2.1 For flame spraying. The gases listed below are recommended for flame spraying. Other gases may be used for a spray procedure if that spray procedure has been qualified for that gas.

Gas	Specification	Type
Oxygen	BB-O-925	Commercial
Acetylene	BB-A-106	Commercial

5.3.2.2 For plasma spraying. Gases for the plasma spray process shall be as follows:

Gas	Specification
Hydrogen	BB-H-886 Pre-purified 99.95 percent Maximum oxygen content 0.05 percent
Nitrogen	Pre-purified Maximum oxygen content 0.002 percent
Argon	MIL-A-18455 High purity Maximum dewpoint minus 76°F
Helium	BB-H-1168, grade A

5.3.3 Abrasive blasting particles. Abrasive blasting particles used for surface preparation shall be aluminum oxide grit to provide the anchor tooth pattern for thermal spray application. Chilled angular iron grit may be used only on carbon and low alloy steels and aluminum substrates. The aluminum oxide particles shall have a 16 to 30 mesh size. The chilled iron grit shall have a 25 to 40 mesh size.

5.3.3.1 Requirements. Abrasive particles shall be clean, dry, sharp, and free of excessive fines. Excessive fines are defined as greater than 25 percent fines.

5.3.3.2 Restrictions. Abrasive particles shall not contain any feldspar or other mineral constituents that tend to break down and remain on the surface. Abrasive particles that may have been used for cleaning heavily contaminated surfaces shall not be used for final surface preparation, even though the abrasive has been rescreened. Grit that is noticeably worn or dull when compared with new grit under a magnification of 10X shall not be used.

5.3.4 Masking materials.

5.3.4.1 For abrasive blasting. Any masking material which provides adequate protection of the substrate and does not cause corrosion or contamination of the spray coating or substrate may be used. Following abrasive blasting, any masking material which is unsuitable as a masking material for the thermal spray process shall be removed.

5.3.4.2 For thermal spraying. Tapes, liquid masking compounds, silicone rubber or metal shielding may be used as thermal spraying masking materials. Tapes used for spray masking shall be designed for high temperature use. Materials shall not cause corrosion or contamination of the sprayed coatings.

5.3.4.3 Irregular shapes. For instances when holes, slots, keyways or other types of recesses cannot be protected by tapes or shields, inserts of carbon or metal may be used. These inserts are left in place during abrasive blasting and spraying, and may be removed upon completion of surface finishing.

5.3.5 Sealants. The sealant, if required, shall be specified for each specific application.

5.4 Process.

5.4.1 Surface condition. Areas to be thermal sprayed, and adjacent areas, shall be free from grease, oil, paint, corrosion products, moisture, or any other substance which may contaminate the coating.

5.4.1.1 Solvent cleaning. Prior to any blasting or spraying, all surfaces which have come in contact with any oil or grease shall be solvent cleaned. Use solvents that comply with local and federal regulations. Vapor degreasing is preferred; however, solvent washing may be used. Solvents shall not cause any detrimental attacks of the substrate material or leave any residue film on the substrate. Due to the flammable and toxic nature of most solvents, proper precautions, such as adequate ventilation shall be followed during solvent cleaning (see 5.4.8 for safety precautions). Precautions shall also be exercised to protect any parts which may be attacked by the solvents. Any anchor tooth surface that has come in contact with oil or grease shall be solvent cleaned or vapor degreased and and then reblasted for new anchor tooth.

5.4.5.4 The direction of the thermal spray shall be as close as possible to an angle of 90 degrees with the surface being coated and not less than 45 degrees.

5.4.5.5 The work shall be allowed to cool normally to room temperature after spraying is completed. If it is necessary to cool the work more quickly, a blast of air, carbon dioxide or other suitable gas may be directed onto the work. The blast shall be maneuvered to obtain a uniform cooling rate over the entire section. There shall not be any quenching with liquid.

5.4.6 Application of sealant. Thermal sprayed coatings shall be sealed after spraying and again after finishing to minimize corrosion of the substrate. The particular sealant selected will depend on the maximum use temperature of the component and the purpose of sealing the coatings. Some applications may not require that a sealant be used, but elimination of the sealant requires NAVSEA approval.

5.4.7 Surface finishing. Surface finishing shall be used to obtain the specified dimensions and to provide a finer surface finish than the as-sprayed condition. Coatings may be used in the as-sprayed condition whenever permitted. The selection or finishing method depends on the type, hardness, and thickness of the coating. The preferred method is grinding; wet grinding is recommended. Soft materials, such as bronze and babbitt, may be single-point machined.

5.4.7.1 Care shall be taken in any machining or grinding operation in order to avoid damage to the coating. Improper techniques during the finishing operation could result in pull-out of particles, thus producing a severely pitted surface or heat checking. The sprayed particles shall be cleanly sheared and not pulled from the surface as a result of the finishing operation.

5.4.8 Safety precautions. Safety practices shall be as follows.

5.4.8.1 Thermal spraying, like any other industrial process has its inherent hazards. Potential hazards include vapors, dusts and fumes, gases, the wire spray gun, noise and arc ultraviolet radiation. These hazards can be eliminated or minimized when proper safety precautions are taken. The requirements of AWS OPP shall be complied with.

5.4.8.2 Approved solvents have vapors that are harmful and can be fatal; and, therefore, shall be used only with adequate ventilation. Prolonged breathing of vapors and repeated contact of solvent with the skin shall be avoided. Toluene and alcohol are also flammable liquids and proper precautionary measures shall be taken.

5.4.8.3 Before opening any gas valve, assure there is adequate ventilation in the work area. Examine all gas equipment regularly for leaks and loose connections, tightening or replacing as necessary. Gas cylinders shall be secured to keep them from falling. Cylinders in use shall be kept away from the thermal spray operation so that molten spray or flame will not reach them. If this is not possible, fire resistant shields shall be provided. When not in use, shut off gas and place valve caps on cylinders.

5.4.8.4 When abrasive blasting in semi-confined spaces, use face shields with dust hoods or helmets with forced fed purified air, to protect the eyes, face, chin and neck from flying particles. Personnel near blasting operations shall wear protective safety eyewear.

5.4.8.5 Maintain thermal spray guns in accordance with manufacturer's recommendations. Do not light the wire gun without wire in the nozzle as flames may shoot back into the gun causing equipment damage and operator injury. When lighting the gun, use a friction lighter; do not use matches.

5.4.8.6 Both abrasive blasting and thermal spraying generate dusts and fumes, posing a respiratory hazard. Adequate ventilation combined with use of proper personal protection equipment normally provide satisfactory protection. In closed areas, a water wash booth with a positive exhaust system shall be used to minimize the hazardous concentrations of dusts and fumes. Appropriate personal respiratory protection shall be worn during spraying and sealing operations. If operator discomfort such as dizziness or nausea develops, stop spraying. Determine the cause for the discomfort and correct the cause before resuming the spraying process.

5.4.8.7 Noise levels generated by the thermal spray process are sufficient to cause temporary deafness or permanent loss of hearing, and fatigue. Ear muffs and properly fitted soft rubber ear plugs shall be worn by thermal spray operators and personnel in the immediate spray vicinity to reduce the high intensity noise levels to acceptable conditions. Use of cotton wads is specifically prohibited.

5.4.8.8 Infrared, visible and ultraviolet radiation from the thermal spray process can cause eye discomfort and damage. When spraying, a suitable filter plate shall be used with the helmet, face shield or goggles as follows:

(a)	Wire flame spraying:	Shades 2 - 4
(b)	Powder flame spraying:	Shades 3 - 6
(c)	Plasma spraying:	Shades 9 - 12
(d)	Wire arc spraying:	Shades 9 - 12

WARNING: Covers shall be placed over windows of the thermal spray facility when spraying to protect the eyes of personnel working outside or passing by.

5.4.8.9 Flame-resistant clothing and leather or rubber gauntlets shall be worn during thermal spraying to keep harmful flying particles from thermal sprayed materials from skin contact. Aluminized clothing may be used, taking care radiation and ultraviolet light are not reflected onto unprotected skin areas. Care shall also be taken as aluminized clothing may present a danger from electric shock.

5.4.8.10 Operators shall wear protective equipment as specified in 5.2.4.

5.4.8.11 Two persons shall be present at all times during the spraying operation; one inside the spray booth and one outside.